STANDARD METHODS OF MECHANICAL TESTING OF
OF BOLTS AND NUTS.

American Institute of Bolt, Nut and Rivet Manufacturers.

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Figs.1,2,3,4.

Recommended

STANDARD METHODS OF MECHANICAL TESTING OF BOLTS AND NUTS

American Institute of Bolt, Nut and Rivet Manufacturers

Approved May 21, 1948

Scope

1. (a) These methods describe the specimens and procedures for the mechanical testing of bolts and nuts.

(b) Where the term "bolt" is used herein, reference is intended also to studs and similar externally threaded fasteners as applicable.

(c) These methods describe a series of procedures for use in testing various products of different grades and types. Only those tests should be used that are applicable to the product in question.

Tension Test

2. (a) Tension tests of bolts shall be taken preferably on the finished bolt with the load applied between the head and a nut or suitable fixture, either of which shall have sufficient thread engagement to develop the full strength of the bolt. The nut or fixture shall be assembled on the bolt leaving three complete bolt threads exposed and unengaged between the grips. Nut or fixture shall be assembled freely to the thread runout and then unscrewed three full turns. Figure 1 illustrates the method for testing a full size specimen. If failure occurs by threads stripping before reaching the minimum required tensile load the individual test shall be discarded.

(b) Where the bolt or thread length is too short for a tension test, acceptance shall be determined by the hardness test described in Section 6.

(c) The tensile strength determination shall be based upon the cross-sectional area of the bolt where the break occurs. The cross-sectional area of the threaded portion used in the determination shall be the mean area as shown in Table I.

(d) Where equipment of sufficient capacity is not available for testing bolts in full size as described in Paragraph (a), tests may be made as follows: Bolts 7/8 to 1 3/8 inches in diameter, inclusive, shall have their shanks turned concentric with the axis of the bolt as shown in Figure 2, leaving the head and the threaded section of the bolt intact. The load shall be applied between a nut or suitable fixture and bolt head. For bolts 1 1/2 inches in diameter, a standard test specimen shall be turned from the bolt, having an axis midway between the center and the outside surface of the bolt shank as shown in Figure 3, with a diameter and gage length as shown in Figure 4.

Elastic Proof Load (Applicable only to Quenched and Tempered Bolts)

3. (a) In determining conformity to specifications for elastic strength, the overall length of a straight sample bolt shall be measured at the true center line; the preferred method of measuring the length shall be between conical centers on the center line of the bolt at the head and point end using mating centers on the measuring anvils; other recognized methods may be used such as ball-point anvils on prepared surfaces at the true center line; sample bolt shall be marked on the shank or head so that it can be

placed in the measuring fixture in the same position for all measurements; the measuring instrument shall be capable of measurement to 0.0001 inch; the bolt shall then be loaded as in the tensile strength test to load equal to the specified elastic proof load; the bolt shall then be removed from the testing machine and its overall length be again determined; the length after loading shall not exceed that before loading by more than 0.0005 inch.

Yield Strength

4. Where determination of yield strength is required and the bolt is of sufficient diameter and length to permit use of the Standard Round Tension Test Specimen with 2-in. Gage Length of Specification E-8 of the American Society for Testing Materials, a test bar shall be turned and tested using extensometer to measure deformation over the gage length. The yield strength shall be the load at which a permanent set in the gage length of 0.2% occurs.

Plastic Deformation

5. (a) Where bolts are tested in full size, plastic deformation shall be determined by the procedure of Section 3 except that the test shall be continued until a specified elongation is obtained on removal of the load. The bolt shall not have ruptured during this test.

(b) For bolts not tested in full size (See Section 2(d)), a standard turned test specimen shall be used and elongation in 2-in. gage length and reduction of area shall be determined.

Hardness Test

6. (a) Hardness of bolts shall be measured on a transverse section through the threaded portion of the bolt at a point one-fourth of the nominal diameter from the axis of the bolt. This section shall be taken at one diameter from the end of the bolt.

(b) Hardness of nuts shall be taken on the top or bottom face of the nut. The prongs of castle (castellated) and slotted nuts shall have been removed.

(c) Hardness measurements shall be made preferably by the Brinell method. Where sections or hardness range do not permit the use of Brinell testing, the Rockwell method may be used. The preparation of the sample and the method of performing the test shall conform to the Standard Method of Test for Brinell Hardness of Metallic Materials (A.S.T.M. Designation: E 10[1] or the Standard Methods of Test for Rockwell Hardness and Rockwell Superficial Hardness of Metallic Materials (A.S.T.M. Designation: E 18)[2]. Conversion of values between these systems shall conform to the Tentative Hardness Conversion Tables for Steel (A.S.T.M. Designation: E 48)[2]. Conversion of hardness measurements to tensile strength shall conform to the conversion table published by the S. A. E.[3]

1/ 1946 Book of A.S.T.M. Standards, Parts I-A and I-B
2/ 1946 Book of A.S.T.M. Standards, Part I-A
3/ "SAE Handbook", 1947 Ed., Soc. Automotive Engrs., Inc., 29 West 39th Street New York 18, New York, pp. 374-378

Head Test

7. During the tension test specified in Section 2 (a) failure shall occur in the shank or the threaded section and not at the juncture of the head and shank.

Stripping Test

8. (a) The sample nut shall be assembled on a hardened, threaded mandrel and the specified test load applied to the nut. Threads of the nut shall not strip at this load. If the threads of the mandrel are damaged during the test, the individual test shall be discarded.

(b) The mandrel shall be threaded to the American Standard Class 3 tolerance except that the major diameter shall be the minimum major diameter with a plus tolerance of 0.002 in.

(c) If the unit tensile stress developed in the mandrel is required, the loads thus obtained shall be divided by the mean thread area as given in Table I.

TABLE I
Mean Thread Area

Nominal Size and Threads per inch	Mean Thread Area (Stress Area) Sq. in.	Nominal Size and Threads per inch	Mean Thread Area (Stress Area) Sq. in.
1/4-20	.0317	7/8-9	.4612
1/4-28	.0362	7/8-14	.5088
5/16-18	.0522	1 - 8	.6051
5/16-24	.0579	1 - 12	.6624
3/8-16	.0773	1 1/8-7	.7627
3/8-24	.0876	1 1/8-8	.7896
7/16-14	.1060	1 1/8-12	.8549
7/16-20	.1185	1 1/4-7	.9684
1/2-13	.1416	1 1/4-8	.9985
1/2-20	.1597	1 1/4-12	1.0721
9/16-12	.1816	1 3/8-6	1.1538
9/16-18	.2026	1 3/8-8	1.2319
5/8-11	.2256	1 3/8-12	1.3137
5/8-18	.2555	1 1/2-6	1.4041
3/4-10	.3340	1 1/2-8	1.4899
3/4-16	.3724	1 1/6-12	1.5799

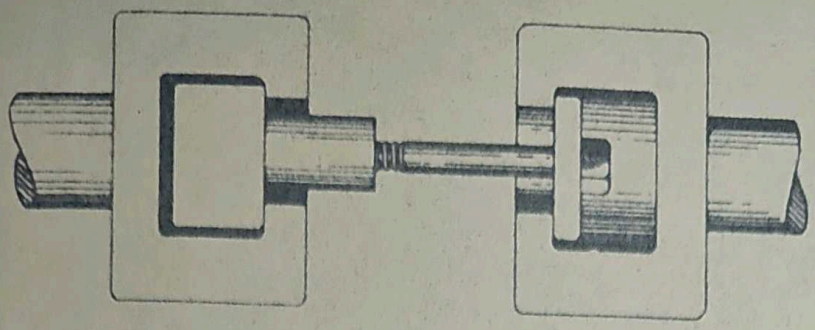


Figure 1 - Tension Testing Full-Size Bolt

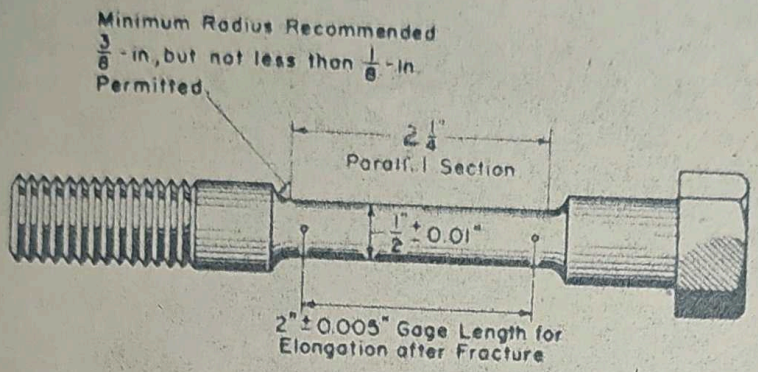


Figure 2 - Tension Test Specimen for Bolt with Turned Down Shank

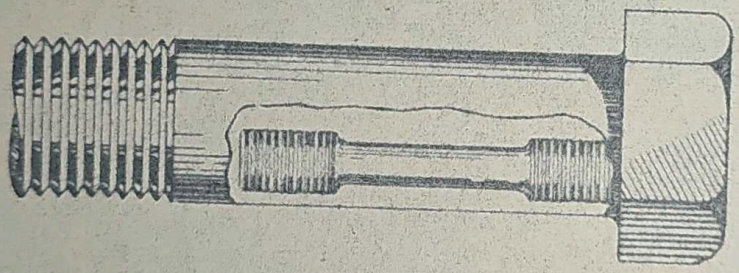
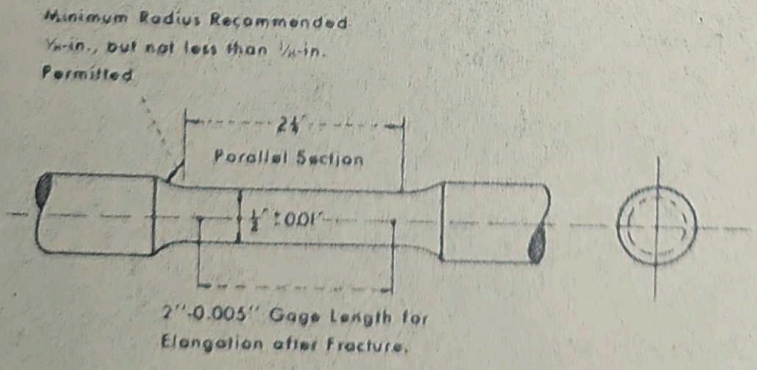


Figure 3 - Location of Standard Round 2-in. Gage Length Tension Test Specimen When Turned from Large-Size Bolt



Note - The gage length, parallel section and fillets shall be as shown, but the ends may be of any shape to fit the holders of the testing machine in such a way that the load shall be axial.

Figure 4 - Standard Round Tension Test Specimen with 2-in. Gage Length